Shepard, Chas. U.

An analysis of rice, rice straw, chaff, etc.

1844.

AN

ANALYSIS

OF

RICE, RICE STRAW, CHAFF, &c

BY

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At a meeting of the Agricultural Society of Winyaw and All-Saints, in Georgetown District, in November, 1843, it was proposed, that an Analysis be made of the Grain, Straw, Chaff, &c. of Rice. This was agreed to, and the task committed to Professor C. U. Shepard, of the Medical College of the State of South-Carolina. The following analysis is the result of his chemical investigations, and was handed to Col. Allston, the Chairman of the Committee appointed, to carry the proposition into effect.

Charleston, S. C., April 6th, 1844.

Dear Sir,

I hasten to lay before you at the earliest moment in my power, the Report on Rice, concerning which I have had communications with yourself and Dr. Parker. I hope it may not disappoint the expectation already formed of the work by yourself, or the Society for which it has been executed.

The task has greatly exceeded in difficulty, the estimate I formed respecting it at the outset; it having occupied me most closely in my Laboratory for at least three weeks. The results given in the report are generally deduced from the averages of repeated analyses.

If the Society publishes my report, I should feel obliged if a copy would be forwarded to the Hon. Mr. Ellsworth, of the Patent Office, Washington, whom I have led to expect such a favor.

And I have the honor to remain,

Most respectfully, your obedient servant,

CHAS. UPHAM SHEPARD.

Hon. R. F. W. Allston.

CHEMICAL EXAMINATIONS

OF THE

RICE PLANT AND RICE SOIL IN SOUTH-CAROLINA.

BY

CHARLES UPHAM SHEPARD.

1.—Of Clean Commercial Rice.

Burned in a porcelain capsule under the muffle, until all combustible matter had disappeared, a blebby glass-like ash remained weighing 0.404 per cent., or less than half a part in one hundred of the rice consumed.* Corrected statement of mineral constituents of clean rice=0.487 per cent.

Composition of 100 *parts of this residuum.*

Phosphate of lime (bone-earth,) with decided traces of intermixed phosphate of magnesia,	76.20
Phosphate of potassa, nearly 5 per cent.,	
Silica, sometimes as high as 20 per cent.,	
And the following salts in traces only. They are enumerated in the supposed order of their abundance, viz:	24.8
Sulphate of potassa,	
Chloride of potassium,	
Carbonate of lime,	
Carbonate of magnesia,	

* It being requisite to determine the inorganic ingredients of rice, and of the various parts of the entire plant, as it may reasonably be supposed, they are returned to the soil again on the decomposition of the plant and its parts, (whether taking place spontaneously or otherwise,) and not to give those ingredients in all cases as they are actually yielded to us in the process of destructive analysis, I shall subjoin many of the constituents of the ashy residua not as found, but rather as the principles of chemistry authorise us to deduce them, in accordance with the above requisition.

2.—Of the Cotyledon.

Commonly called the eye or chit of the grain.

Ignited under a muffle on a porcelain plate, it burns with a bright light, and the ash flows into a glass. From the intimate way in which it adhered to the plate, it was impossible to determine its weight or even its composition in a satisfactory manner. The expression 6.824 per cent., however, may be taken as an approximation to the weight of the residuum. In composition, it appears scarcely to differ from the ash of clean rice, except in being somewhat richer in lime, and in the phosphoric and sulphuric acids.

3.—Of the fine Rice Flour.

As it comes down on the bulk.

It gives on burning, a bulky, porous ash, weighing 10.746 per cent., of the flour consumed. Corrected as above=12.30 per ct.

Composition of 100 *parts of this residuum, as follows:*

Silica, with traces of combined potassa,	- -	38.02
Phosphate of lime, with traces of phosphate of magnesia,		54.60
Phosphate of potassa, (rich in this salt,)		
Sulphate of potassa,		
Sulphate of lime, in traces,	and loss,	7.38
Chloride of calcium, "		
Chloride of potassium, "		
Lime and magnesia, "		
		100 00

4.—Of coarse Rice Flour.

From the bulk.

It gives on burning, a bulky, porous ash=11.23 per cent. Corrected statement=11.831 per cent.

Composition of 100 *parts of this residuum, as follows:*

Silica, with traces of combined potassa,	- -	69.27
Phosphate of lime, with traces of phosphate of magnesia,		28.94

Phosphate of potassa, (rich in this salt,)	} and loss,	6.79
Carbonate of potass, in traces,		
Sulphate of potassa "		
Lime and magnesia, "		
Chloride of calcium, "		
Chloride of potassium, "		
		100.00

5.—Of the Husk.

Commonly called chaff, or offal.

Burns with little or no flame, into a perfectly white, silicious skeleton of the husk. In weight, it equals 13.67 per cent.

Composition of 100 *parts of this residuum, as follows:*

Silica,		97.551
Phosphate of lime, with traces of alumina and oxides of iron, and manganese,		1.023
Carbonate of lime,		0.294
Phosphate of potassa,	} and loss,	1.132
Sulphate of potassa, in traces,		
Chloride of potassium, "		
Carbonate of potassa, "		
		100.000

6.—Of the Rice Straw.

Burns into an ash which is a semi-fused, glassy frit. It weighs 12.422 per cent.

Composition in 100 *parts, as follows:*

Silica,		84.75
Potassa, with probable traces of soda, combined with the above silica,		8.69
Phosphate of lime, with traces of oxide of iron (and manganese?)		2.00
Carbonate of lime,		2.00
Alumina, in traces,	} and loss,	2.56
Phosphate of potassa,		
Carbonate of potassa,		
Sulphate of potassa,		
Chloride of potassium,		
		100.00

7.—Rice Soil from Waverly Island.

Silica, with fine sand, one-third of which is feldspathec and slightly magnesian or talcose; and contains alumina with from 2 to 4 per cent. of potassa, mingled with soda and magnesia,		47.75
Alumina, partly combined with humic acid,		12.35
Peroxide of iron (combined with humus,) with decided traces of phosphate of lime, (bone-earth,)		4.15
Carbonate of lime, with traces of magnesia,		0.40
Water of absorption,	8.50	
Humus, (organic matter,)	23.50	32.00
Chloride of calcium, Sulphate of lime, Sulphate of magnesia, Sulphate of potassa, Chloride of sodium,	and loss,	1.35
		100.00

8.—Rice Soil from Woodville, Main, Waverly.

Silica, with fine sand, as above,		57.50
Alumina, partly combined with humic acid,		10.45
Peroxide of iron (combined with humus,) with decided traces of phosphate of lime,		4.60
Carbonate of lime,		0.40
Carbonate of magnesia,		0.58
Water of absorption,	7.50	
Humus,	17.80	25.30
Chloride of calcium, Sulphate of lime, Sulphate of magnesia, Sulphate of potassa, Chloride of sodium,	and loss,	1.17
		100.00

9.—Rice Soil from Matanzas on the Main.

Silica, with fine sand, as above, - - -	60.50
Alumina, partly combined with humic acid, - -	8.15
Peroxide of iron (combined with humus,) with decided traces of phosphate of lime,	3.00
Carbonate of lime, with traces of magnesia, - -	0.85
Water of absorption, 9.00	
Humus, - - 18.50 - - -	27.50
Chlorides of calcium and of sodium, Sulphates nearly as above, and loss, -	1.00
	101.00

10.—Rice Soil from Dr. Parker.

Silica, with fine sand, as above, - - -	41.25
Alumina, (combined with humus,) - - -	9.25
Peroxide of iron, (combined with humus,) - -	3.30
Phosphate of lime, - - - - -	0.55
Carbonate of lime, - - - - -	0.85
Carbonate of magnesia, - - - -	0.45
Water of absorption, 9.50	
Humus, (with odor of ammonia,) 33.50 -	43.00
Chloride of calcium, abundant, Chloride of sodium, Sulphate of lime, Sulphate of magnesia, Sulphate of potassa, and loss, -	1.35
	100.00

Additional particulars, with some consequences from the foregoing.

[1.] 100 parts by weight of rough rice, (from which the remains of stems and glume-leaflets had been separated,) gave

82.10 parts of grain, and
17.90 " husk.

100.00

[2.] 100 parts of unhusked grain, gave
95.238 parts of non-cotyledonous grain, and
4.762 " cotyledons, or eyes.

100.000

[3.] 100 parts of non-cotyledonous unhusked grain, gave
94.3 of grain without husk, cotyledon or epidermis,
5.7 of epidermis, or inner coat.

100.00

[4.] 100 parts of rough rice, then has
17.900 husk.
3.909 cotyledon.
4.456 epidermis.
73.735 clean grain.*

100.000

[5.] The ratio of rough-rice to the straw of the harvested grain, deduced from taking the mean of 15 separate experiments, gave the weight of the grain 53.5, that of the straw, including the panicle or stems, 23.6.

But as many of the leaves appear to have been mutilated, I am disposed to assume as a probable approximation to the truth, the weight of the grain as just double that of the cut-straw. And as some observation of the stubble and roots strongly favors the idea of their equalling together the weight of the straw, I shall still farther venture to consider the rough-rice of a ripe, harvested plant as equal in weight, that of the entire stem, leaves and root.

[6.] Let us next attempt an approximation towards an appreciation of the mineral constituents of these different portions of the rice plant.

* From losses sustained to the clean grain, in the process of milling, it is not probable that above 70 parts of commercial rice are afforded by 100 of rough-rice.

The ash in 100 parts of rough-rice equals 4.762 parts. And as the ash in 100 of the husk, equals 13.67, that in 17.90 parts of husk must equal 2.446 parts. By difference, therefore, between 2.446 and 4.762, the ash of the cotyledon, epidermis and clean grain, in 100 parts of rough-rice, will equal 2.316 parts.

But the percentage of the ash in clean rice being known, we are able to state what the amount of ash is. In clean rice of 100 parts rough-rice, it is 0.297 parts. The general statement, then, will stand thus, for 100 parts rough-rice.

Ash in the husk,	2.446 parts.
" cotyledon and epidermis,	2.019 "
" clean grain,	0.297 "
	4.762

[7.] The straw (including the stubble and root,) having been assumed as equal in weight to the rough grain, the ratio of the mineral ingredients of the former to the latter, stands as 12.422 to 4.762.

[8.] Considering a single rice-plant, in its dry, mature state, to weigh 100 grains, (a supposition which will often accord with the fact,) we shall have of mineral matter in the different parts of the plants, the following number of grains:

In the stubble and root,	36.08
" straw and pan leaves,	36.08
" husk,	14.20
" cotyledon and epidermis,	11.70
" clean rice,	1.94
	100.00

As however in the milling, nearly one-sixth of the cotyledon still adheres to the grain, for all practical estimates; it will be nearer the truth to state the mineral ingredients of clean rice at 2 per cent, those of the whole crop, and to diminish therefore, the residuum of the cotyledon and epidermis by 0.06 per cent., making the per centage statement to stand thus:

Stubble and root,	36.08
Straw and leaves,	36.08
Husk,	14.20
Cotyledon and epidermis,	11.64
Clean rice, (commercial)	2.00
	100.00*

[9.] If the foregoing views are correct, it becomes plain, at a glance, that the planter who sells his crop in the condition of rough rice, robs his lands of 27.84 per cent. of the mineral ingredients of this species of produce; while on the other hand, he who sells it as clean rice, substracts from them but 2 per cent. of these ingredients.

But the true value of these constituents cannot be rightly estimated by their numerical proportions, since the mineral ingredients of the cotyledon and epidermis consist of above 50 per cent. of the most precious saline substances, while in those of the stubble, root and husk, the like constituents scarcely rise to 10 per ct.

[10.] From the extreme slowness with which the husk suffers conversion into humus, unless fermented with stable litter, this portion of the rice-plant appears to be almost wholly neglected by the planter. But as it contains above 30 per cent. of carbon, it must be capable, when incorporated with the soil, of performing to a considerable extent the functions of humus, *i. e.* of gradually giving rise to carbonic acid from combining with the oxygen of the air, and of raising the temperature of the soil by its eremacau-

* It may be useful to present here, also, a *per centum* view of the incombustible constituents of the rough-rice.

Husk, - - -	51.00
Cotyledon and epidermis,	41.81
Clean rice, - - -	7.19

It scarcely need to be stated, that the cotyledon and epidermis are found in the coarse rice flour, intermingled largely with the husk, and with from 3 to 4 per cent. of powdered clean rice. The cotyledon and the epidermis are richer than the clean rice in saccharine matter and gluten, which materially augment the value of rice flour as a feed for cattle and swine. These principles are thus returned to the soil under the most favorable conditions for agriculture.

sis, or slow combustion. Besides, its minutely divided silica, is in a more favorable condition for absorption by the rootlets of plants, than that which is offered to them by the soil itself. We may add to these supposed useful properties of the husk, the mechanical service which in certain stiff, compact lands it is capable of exerting, by keeping the ground open to the access of air, and as an absorbent of moisture. As it is unlike to the stalk and leaf, in not containing alkali, it might perhaps be found advantageous to add wood-ashes along with it to the soils on which it is applied.

The extraordinary results, so fully proven of late, to flow from the use of minutely divided charcoal, would perhaps authorise another mode of treating the rice offal, which is to burn it with a smothered combustion in small kilns, or in heaps partly covered with soil, whereby it might be converted into a species of charcoal. I should anticipate from such a preparation of the husk, whether applied alone, or previously mixed up with putrescent matters into a compost, the most marked effects.*

I conclude this report with the hope, that this inquiry, which is by no means supposed to have exhausted the subject, or to have reached that rigid accuracy of result, which it is to be hoped may one day be obtained, may afford the rice planter more valid reasons than he before had, for husbanding those mineral elements of his crop with a religious care, the neglect of which, with whatever apparent impunity it may at first be attended, cannot fail in the end to involve him in a hopeless struggle against nature.

C. U. SHEPARD.

Charleston, April 6th, 1844.

* I need scarcely to add, that the different composition of the stem and leaves of the rice, would scarcely justify a similar procedure with these parts of the plant, since unless the temperature be regulated with great care, the silica would form with the associated alkali, a true glass, which for agricultural purposes, would be nearly as inoperative as common sand.